U.S. FOREST SERVICE

RESEARCH NOTE LS-14

LAKE STATES FOREST EXPERIMENT STATION • U.S. DEPARTMENT OF AGRICULTURE

Litter Fuels in Red Pine Plantations

The weight and composition of forest fuels in red pine plantations are being studied over a large area in central Lower Michigan. These studies are designed to produce basic information on total volume, moisture content, composition, and distribution of combustible material available in specific forested areas. To date, only red pine plantations have been studied. Fuel weight — especially available fuel weight — is an important factor in predicting fire behavior and intensity. Other factors that may be equally important are fuel moisture content, fuel size and arrangement, and chemical composition.

As a part of the Lake States Station's fuels study, some detailed measurements have been made on ground fuels under plantation stands (fig. 1). This work is a continuation and expansion of the red pine plantation fuel work done by LaMois[1] in 1958. In 1961, 16 separate stand conditions were sampled. In each of these, two 1/10-acre plots were randomly located. Age, site, and stand density were determined, and 10 subsamples of forest floor material were collected from each plot. The subsamples consisted of all dead organic material on the forest floor that could be readily separated from the mineral soil. In young red pine plantations, there appears to be a sharp line that separates combustible material from the layer that is predominantly mineral soil.

As each subsample was collected, it was divided into two parts: The *L* layer (litter) and the *F* layer (all material below the *L* layer to mineral soil). The layers were relatively easy to separate by carefully removing the surface needles down to where the darkened needles were matted and lightly bound together by fungus mycelium. These two layers of material make up that portion of the forest floor that would be consumed by fire if the fuel moisture content was sufficiently low. The *L* layer is the surface fuel component that changes rapidly in moisture content and contributes to rate of fire spread.

Individual samples were analyzed in the laboratory by determining the oven-dry weight of the needles in the *L* layer, branchwood in the *L* layer, all material in the *F* layer, and miscellaneous material such as bark and cones. From this, a total dry-weight value was determined and applied on a per-acre basis.

Depth measurements were also made of both *L* and *F* layers. Four depth measurements were averaged for each subsample. Knowing the depth of the *L* and *F* layers and the corresponding weight per acre for both layers, a total weight per acre of forest floor material was determined.

By separating the two layers and obtaining both depth and weight for each layer, density values were computed that reflect rather clearly why the less dense litter layer changes moisture content rapidly and may burn more

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[1] *LaMois, Loyd. Fire fuels in red pine plantations. U.S. Forest Serv., Lake States Forest Expt. Sta., Sta. Paper 68, 19 pp., illus. 1958.*

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FIGURE 1. — A typical plantation of good site, 33-year-old red pine showing surface fuel conditions. This stand contains approximately 150 square feet of basal area and nearly 10 tons of combustible surface fuels per acre.

readily. They also show why the *F* layer, with higher density, may retain more moisture and burn as a smoldering fire. These density values are:

L layer — 7,000 lbs. per acre-inch
F layer — 11,600 lbs. per acre-inch
Average forest floor — 9,300 lbs. per acre-inch

The *total weight* of forest floor fuels correlates well with basal area in the stands that were sampled. Figure 2 shows a weight prediction curve based on stand density or basal area per acre. Stand age may also be used to strengthen the prediction equation for determining total weight per acre, but was not included in plotting the data for figure 2.

Litter weight (*L* layer) also correlates well with stand density in stands 15 to 25 years in age (fig. 3). Not enough stands older than 25 years were available for a representative sample in that category. The stands younger than about 10 years still had a mixture of grass and weeds on the ground that precluded meaningful fuel estimates.

This study has established a procedure for systematically sampling surface fuel conditions in pure plantations of red pine. The work should now be extended to cover other conifer types and stands of mixed conifers, as well. It is generally recognized that surface fuel weights increase with both stand age and stand density. The amount of these increases has not been established for Lake States forest types. Surface materials are an important fuel component in established pine stands or plantations. Fuel volume determinations for these stands may eventually create a better understanding of fuel-fire relationships.

J. H. DIETERICH
Research Forester
(Forest Fire Research)

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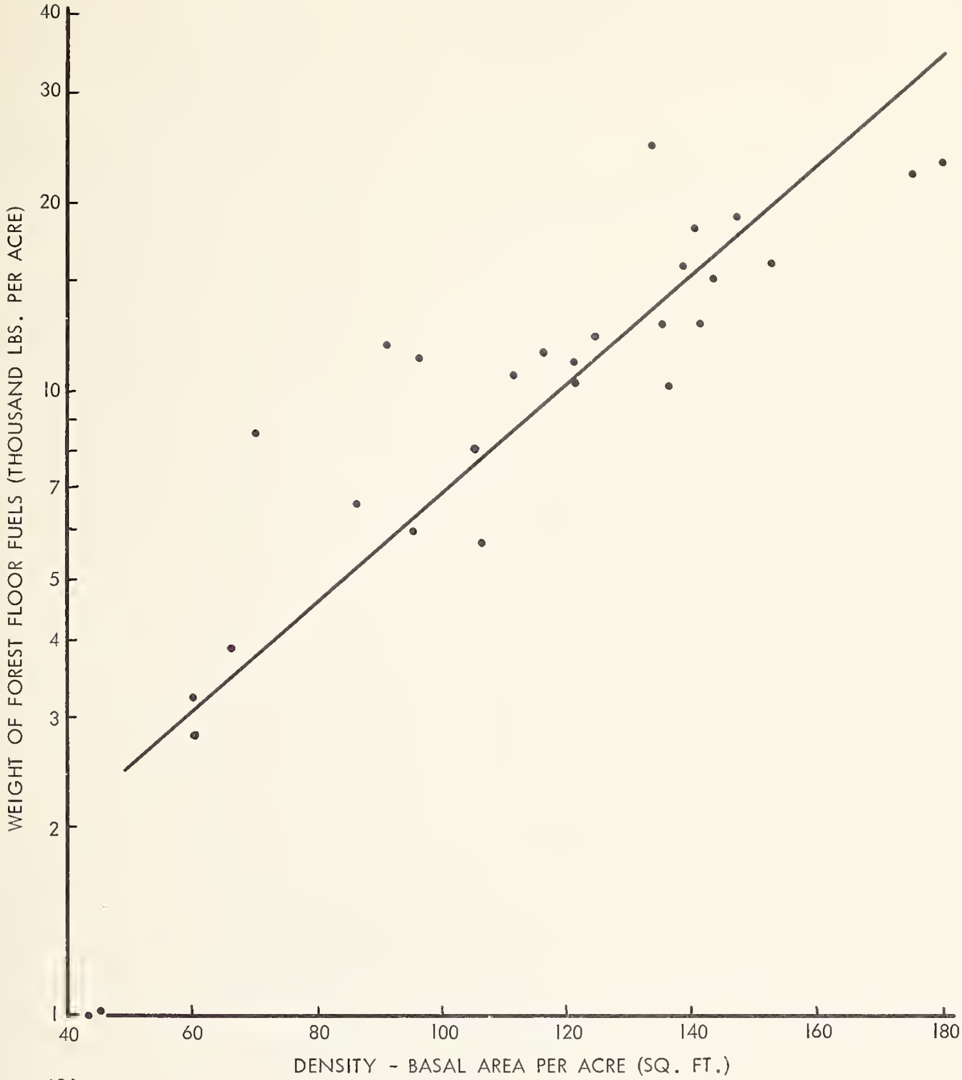

FIGURE 2. — weight of forest floor fuels, according to stand density in red pine plantations on good sites in Lower Michigan. The prediction equation is as follows:

Log (forest floor fuel weight) = 2.9640 + .00877 (basal area/acre)

$r^2 = .796$.

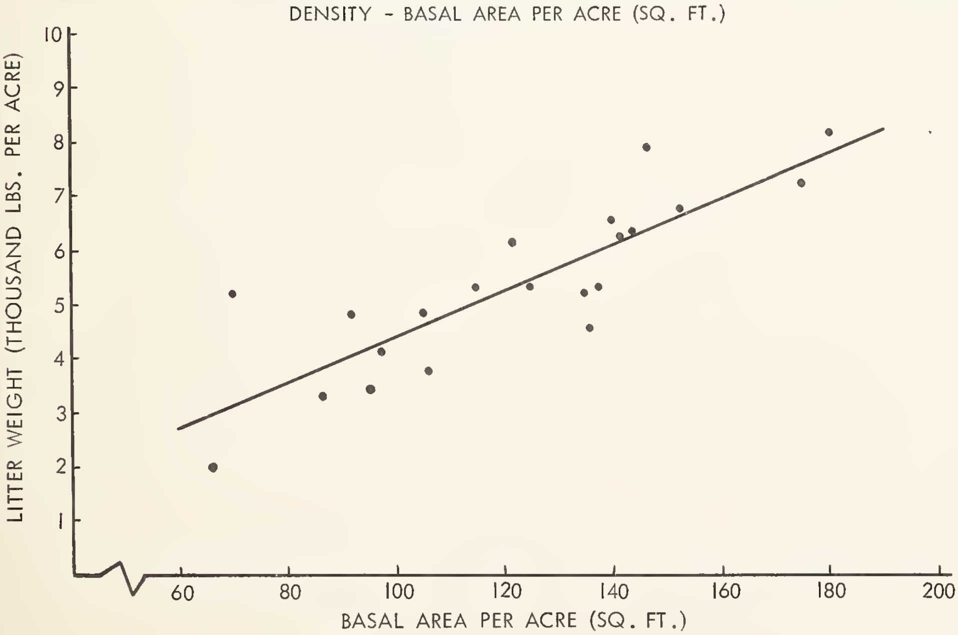

FIGURE 3. Weight of upper layer needles or litter on good site red pine plantations, 15 to 25 years old, Lower Michigan. The prediction equation is as follows:

$Y = 355 + 41.18X$

$r^2 = .734$